

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

DIARY ENTRY	
Date <u>29/3/02</u>	Initials <u>Z. M.</u>

To:

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GRANDE BRETAGNE

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NEWCASTLE

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing (day/month/year)	19.11.2001
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Applicant's or agent's file reference RMV/P95364WO	IMPORTANT NOTIFICATION
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International application No. PCT/GB00/03614	International filing date (day/month/year) 21/09/2000	Priority date (day/month/year) 29/09/1999
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Applicant

UNIVERSITY OF DURHAM et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Miehle, S Tel. +49 89 2399-7265




PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference RMV/P95364WO		FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB00/03614	International filing date (day/month/year) 21/09/2000	Priority date (day/month/year) 29/09/1999	
International Patent Classification (IPC) or national classification and IPC F16L55/34			
Applicant UNIVERSITY OF DURHAM et al.			
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 1 sheets.</p>			
<p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> I <input checked="" type="checkbox"/> Basis of the report II <input type="checkbox"/> Priority III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability IV <input type="checkbox"/> Lack of unity of invention V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement VI <input type="checkbox"/> Certain documents cited VII <input checked="" type="checkbox"/> Certain defects in the international application VIII <input checked="" type="checkbox"/> Certain observations on the international application 			
Date of submission of the demand 12/04/2001		Date of completion of this report 19.11.2001	
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465		Authorized officer Avramidis, P Telephone No. +49 89 2399 7317	



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/03614

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*):

Description, pages:

1-9 as originally filed

Claims, No.:

1-19 as originally filed

20,21 as received on 06/10/2001 with letter of 04/10/2001

Drawings, sheets:

1/4-4/4 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/03614

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-21
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-21
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-21
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

The present invention relates to vehicles for travelling along conduits having fluid flowing therein.

Such vehicles are known from, for example WO 86/01751 (D1). This pipeline inspection vehicle is provided with a turbine driven by the fluid flow, the turbine in turn driving wheels biased against the pipeline wall. The drive system is reversible, so that the pig may move both with and against the fluid flow in the pipeline.

With the features of claim 1 of the present invention, an improved alternative vehicle for travelling along a pipeline is given. In particular, by the feature of applying various gripping forces of first and second surface engaging means by moving towards or away from each other, the vehicle can be propelled effectively along the conduit in the opposite direction to the direction of fluid flow without being restricted in range.

None of the prior art documents which have become known to this Authority discloses all the technical features of independent claim 1.

Furthermore, the solution to the above mentioned problem in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) since it is not taught or suggested by the prior art documents.

Claims 2-21 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

Therefore, the present application meet the requirements of Article 33(2) and (3) PCT, because the subject-matter of claims 1-21 is new and involves an inventive step.

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB00/03614

Re Item VII

Certain defects in the international application

1. Independent claim 1 is not in the two-part form in accordance with Rule 6.3(b) PCT, with those features known in combination from the prior art document WO 86/01751 (D1) being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).
2. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).
3. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the document D1 is not mentioned in the description, nor is this document identified therein.

Re Item VIII

Certain observations on the international application

1. The vague and imprecise statement in the description on page 9, last paragraph concerning the "scope of the invention" implies that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them (see also the PCT Guidelines, III-4.3a).

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20. A vehicle according to any one of the preceding claims, further comprising conduit inspection means.

21. A vehicle according to any one of the preceding claims, further comprising conduit repair means.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference RMV/P95364WO	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB00/03614	International filing date (day/month/year) 21/09/2000	Priority date (day/month/year) 29/09/1999
International Patent Classification (IPC) or national classification and IPC F16L55/34		
Applicant UNIVERSITY OF DURHAM et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 5 sheets, including this cover sheet.

- ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 1 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 12/04/2001	Date of completion of this report 19.11.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Avramidis, P Telephone No. +49 89 2399 7317 

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/03614

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-9 as originally filed

Claims, No.:

1-19 as originally filed

20,21 as received on 06/10/2001 with letter of 04/10/2001

Drawings, sheets:

1/4-4/4 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/03614

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-21
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-21
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-21
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB00/03614

R I t m V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

The present invention relates to vehicles for travelling along conduits having fluid flowing therein.

Such vehicles are known from, for example WO 86/01751 (D1). This pipeline inspection vehicle is provided with a turbine driven by the fluid flow, the turbine in turn driving wheels biased against the pipeline wall. The drive system is reversible, so that the pig may move both with and against the fluid flow in the pipeline.

With the features of claim 1 of the present invention, an improved alternative vehicle for travelling along a pipeline is given. In particular, by the feature of applying various gripping forces of first and second surface engaging means by moving towards or away from each other, the vehicle can be propelled effectively along the conduit in the opposite direction to the direction of fluid flow without being restricted in range.

None of the prior art documents which have become known to this Authority discloses all the technical features of independent claim 1.

Furthermore, the solution to the above mentioned problem in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) since it is not taught or suggested by the prior art documents.

Claims 2-21 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

Therefore, the present application meet the requirements of Article 33(2) and (3) PCT, because the subject-matter of claims 1-21 is new and involves an inventive step.

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB00/03614

Re Item VII

Certain defects in the international application

1. Independent claim 1 is not in the two-part form in accordance with Rule 6.3(b) PCT, with those features known in combination from the prior art document WO 86/01751 (D1) being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).
2. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).
3. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the document D1 is not mentioned in the description, nor is this document identified therein.

Re Item VIII

Certain observations on the international application

1. The vague and imprecise statement in the description on page 9, last paragraph concerning the "scope of the invention" implies that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them (see also the PCT Guidelines, III-4.3a).

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference RMV/P95364W0	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/GB 00/ 03614	International filing date (day/month/year) 21/09/2000	(Earliest) Priority Date (day/month/year) 29/09/1999
Applicant UNIVERSITY OF DURHAM et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1

☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/03614

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16L55/34

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16L B08B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 167 829 A (BRITISH NUCLEAR FUELS PLC) 4 June 1986 (1986-06-04) abstract; claims 1,3; figures 1A,1B,1C page 1, line 7 - line 29 page 1, line 63 - line 70 ----	1,2,4,5, 13,20,21
A	DE 27 56 561 A (ROULAND DANIEL) 21 June 1979 (1979-06-21) claims 1,3; figures 1,2 page 4, line 16 - line 25 page 7, line 5 -page 8, line 1 ----	1,2,4,5, 13
A	WO 86 01751 A (STORESUND PER) 27 March 1986 (1986-03-27) abstract; claims 1,2; figure 1 page 2, line 37 -page 3, line 13 -----	1,6, 19-21

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

G document member of the same patent family

Date of the actual completion of the international search

18 April 2001

Date of mailing of the international search report

25/04/2001

Name and mailing address of the ISA

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Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Balzer, R

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/03614

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
GB 2167829	A	04-06-1986	NONE		
DE 2756561	A	21-06-1979	NONE		
WO 8601751	A	27-03-1986	NO	843686 A	18-03-1986
			AU	4809385 A	08-04-1986
			EP	0195797 A	01-10-1986
			NO	861935 A	15-05-1986
			NO	156387 B	01-06-1987

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
5 April 2001 (05.04.2001)

PCT

(10) International Publication Number
WO 01/23213 A2

(51) International Patent Classification⁷: B60R

(21) International Application Number: PCT/GB00/03614

(22) International Filing Date:
21 September 2000 (21.09.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
9923000.5 29 September 1999 (29.09.1999) GB

(71) Applicant (for all designated States except US): UNIVERSITY OF DURHAM [GB/GB]; Old Shire Hall, Old Elvet, Durham DH1 3HP (GB).

(72) Inventors; and

(75) Inventors/Applicants (for US only): APPLETON, Ernest [GB/GB]; 9 Dunelm Court, South Street, Durham DH1 4QX (GB). STUTCHBURY, Neil, William [GB/GB]; 8 Glencourse, East Boldon, Tyne & Wear NE36 OLW (GB).

(74) Agent: VINSOME, Rex, Martin; Urquhart-Dykes & Lord, St. Nicholas Chambers, Amen Corner, Newcastle Upon Tyne NE1 1PE (GB).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

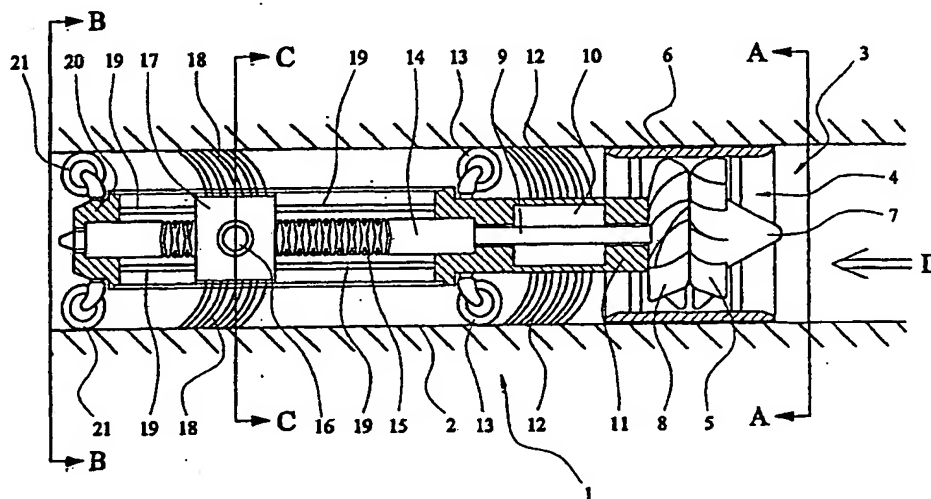
(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

— Without international search report and to be republished upon receipt of that report.

[Continued on next page]

(54) Title: CONDUIT TRAVERSING VEHICLE



(57) Abstract: A vehicle (1) for travelling along a conduit (2) having fluid flowing therein is described. The vehicle comprises a forward set of resilient bristles (12) and a rear set of bristles (18) which are adapted to move towards and away from the forward bristles (12). The forward bristles (12) engage the surface of the conduit (2) and apply a greater gripping force when they are moving towards the rear bristles (18) than when they are moving away from the rear bristles (18). Similarly, the rear bristles (18) apply a larger gripping force to the surface of the conduit (2) when they are moving away from the forward bristles (12) than when they are moving towards the forward bristles (12). A drive means (4) has a shaft (9) which is rotated by fluid flow, and a reverse traverse screw (14) is connected to the shaft such that rotation of the shaft (9) causes a thread follower (16) to move along the reverse traverse screw (14) first in one direction, and then the other, to move the forward (12) and rear (18) bristles towards and then away from each other. This causes the vehicle (1) to move along the conduit (2).

WO 01/23213 A2



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

CONDUIT TRAVERSING VEHICLE

The present invention relates to vehicles for travelling along conduits having fluid flowing therein, and relates particularly, but not exclusively, to vehicles for travelling along liquid transportation pipelines having liquid flowing therein.

In many industries, it is important to be able to gain access to pipelines for maintenance and/or inspection. Pipeline inspection vehicles are known which engage the internal surface of a pipeline and propel themselves along the pipeline, deriving power from a remote power source connected to the vehicle by means of an umbilical cable.

Such known pipeline inspection vehicles are generally only used for pipelines in which no fluid is flowing and if the distance to be travelled is relatively short (up to 1km). If fluid is present and flowing it is possible to use a pig which uses the pressure of the fluid acting over sealing cups to propel the vehicle forward, that is, with the flow of the fluid. However, most conventional pigs are only uni-directional and, as such, must be recovered via a pig receiving trap at the opposite end of the pipeline. If a pig receiving trap is not fitted, which is often the case, then it is desirable to have a bi-directional vehicle. Such long range bi-directional vehicles do not presently exist. As a result of this drawback, it is usually necessary to suspend operation of the pipeline for the duration of the vehicle operation. In the case of industries such as the oil or petroleum industry, ceasing operation of a pipeline for the duration of a maintenance and/or inspection operation can involve unacceptably high cost.

Preferred embodiments of the present invention seek to overcome the above disadvantages of the prior art.

According to the present invention, there is provided a vehicle

-2-

for travelling along a conduit having fluid flowing therein, the vehicle comprising:

- (a) propulsion means including first surface engaging means for engaging a surface of the conduit to apply a gripping force thereto, and at least one second surface engaging means located forwardly in use of said first surface engaging means and adapted to engage a surface of the conduit to apply a gripping force thereto and adapted to move towards and away from said first surface engaging means, wherein the or each said second surface engaging means in use applies a greater gripping force when it is moving towards said first surface engaging means than when it is moving away from said first surface engaging means, and said first surface engaging means applies a larger gripping force when it is moving away from the or each said second surface engaging means than when it is moving towards the or each said second surface engaging means, to cause said propulsion means to move along the conduit;
- (b) drive means having a shaft portion adapted to be rotated as a result of fluid flow relative to the drive means; and
- (c) connector means for causing the or each said second surface engaging means to move away from said first surface engaging means as a result of rotation of said shaft portion.

The present invention is based on the surprising discovery that sufficient energy can be generated from the fluid flow relative to the vehicle to propel the vehicle along the conduit in the opposite direction to the direction of fluid flow. This provides the advantage that the vehicle can under certain circumstances access previously inaccessible conduits, and can crawl "outwards" from a launching point against the flow of

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fluid and swim back an almost infinite distance to its launching point with the flow of fluid, and transport of fluid along the conduit does not need to be suspended while the vehicle is in operation. In the case of the oil and petroleum industries, this avoids the unacceptably high cost of shutting a pipeline down.

Preferably, said first and/or second surface engaging means comprises a respective plurality of resilient bristles.

By providing bristles such that the external diameter of the vehicle at the bristles is greater than the internal diameter of the conduit, the bristles can engage the internal surface of the conduit oriented in the opposite direction to the direction of travel of the vehicle. This enables the frictional force between the bristles and the conduit to be greater in one direction than in the other. This provides the further advantage that no further energy input is required to cause the bristles to apply a gripping force to the surface of the conduit, and enables the propulsion means to be constructed in a simple and cost effective manner.

Alternatively, the first and/or second surface engaging means may comprise a respective electrically and/or magnetically operated gripping means.

In a preferred embodiment, said first and/or second surface engaging means is mounted to a respective vehicle body portion and adjacent pairs of said body portions are adapted to move relative to each other.

In an alternative embodiment, said first and/or second surface engaging means is mounted to a single vehicle body portion.

The drive means may comprise at least one turbine.

At least one said turbine may be a multi stage turbine.

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This provides the advantage of increasing the efficiency with which rotational energy of the shaft portion is derived from fluid flow relative to the drive means.

The drive means preferably further comprises at least one stator for altering direction of fluid flow to increase efficiency of transfer of energy from the fluid to at least one said turbine.

For example, the or each said stator may alter the direction of fluid flow to maximise the extent to which fluid contacts blades of at least one said turbine substantially perpendicularly to the face of the blades to maximise efficiency of energy transfer.

In a preferred embodiment, said connector means comprises a first part having at least one first cam groove and a second part having at least one cam projection adapted to engage at least one said first cam groove such that rotation of said shaft portion in a first sense causes at least one said cam projection to move along a said first cam groove to cause at least one said second surface engaging means to move away from said first surface engaging means.

This feature is based on the highly surprising discovery that contrary to expectations, by providing a first part having at least one first cam groove and a second part having at least one cam projection, sufficient energy can be derived from rotation of the shaft portion to cause at least one said second surface engaging means to move away from the first surface engaging means.

The first part may further include at least one second cam groove to cause at least one said second surface engaging means to move towards said first surface engaging means.

In a preferred embodiment, the or each said first cam groove

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has a smaller pitch than the or each said second cam groove.

Since movement of the or each said second surface engaging means away from said first surface engaging means requires more energy than movement towards said first surface engaging means (because movement of the first and second surface engaging means away from each other generally involves moving the second surface engaging means, drive means and connector means against the flow of fluid, whereas movement of the surface engaging means together generally only involves movement of the first surface engaging means against the flow of fluid), by providing the or each said second cam groove of larger pitch than the or each said first cam groove, this provides the advantage of enabling the or each second surface engaging means to be moved towards the first surface engaging means as rapidly as possible.

In a preferred embodiment, at least one said first cam groove is connected to at least one said second cam groove, and at least one said cam projection is adapted to transfer between said first and second cam grooves to reverse the direction of travel of the first part relative to the second part.

The vehicle may further comprise biasing means for urging at least one said second surface engaging means towards said first surface engaging means.

This provides the advantage that the propulsion means can under certain circumstances be constructed in a relatively simple manner, without the need for the connector means to cause the or each second surface engaging means to move towards said first surface engaging means.

The vehicle may further comprise at least one gearbox connected between said drive means and said connector means.

This provides the advantage of giving a mechanical advantage

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which enables the vehicle to travel more efficiently along the conduit.

In a preferred embodiment, the vehicle is articulated.

This provides the advantage of enabling the vehicle to negotiate bends in the conduit.

The vehicle is preferably articulated rearwardly of said drive means in use.

The vehicle preferably further comprises braking means for increasing the fluid drag of the vehicle.

This provides the advantage of enabling the vehicle to travel with the flow of fluid along the conduit when the vehicle is to be recovered from the conduit.

The braking means preferably comprises at least one sealing means for sealingly engaging the internal surface of the conduit.

The vehicle may further comprise one or more wheels for engaging the surface of the conduit.

The vehicle may further comprise conduit inspection means.

The vehicle may further comprise conduit repair means.

As an aid to understanding the invention, a preferred embodiment thereof will now be described, by way of example only and not in any limitative sense, with reference to the accompanying drawings, in which:-

Figure 1 is a partial longitudinal cross-sectional view of a conduit traversing vehicle embodying the present invention:

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Figure 2 is a view along the line A-A in Figure 1;

Figure 3 is a view along the line B-B in Figure 1; and

Figure 4 is a view along the line C-C in Figure 1.

Referring in detail to Figure 1, a vehicle 1 for travelling along a conduit 2 such as a pipeline having a fluid 3 such as oil flowing therein in the direction of arrow D comprises a drive means 4 including a turbine 5 located within a housing 6. The turbine 5 has a stator 7 (the function of which will be described below) and a rotor 8 connected to a shaft 9 via a gearbox 10 such that movement of fluid 3 in the direction of arrow D causes rotation of the rotor 8 which in turn causes rotation of the shaft 9.

A first body member 11 is connected to the drive means 4 such that the shaft 9 can rotate relative to the body member 11. The body member 11 carries a first set of resilient bristles 12 having an external diameter greater than the internal diameter of the conduit 2 so that the bristles 12 engage the internal surface of the pipeline 2 and point in the direction of arrow D. The body member 11 also carries a set of wheels 13 for engaging the internal surface of the conduit 2 and centralising the vehicle 1 within the conduit.

A reverse traverse screw 14 is connected to the shaft 9 and has two sets of cam grooves 15 in its surface which mate with a thread follower 16 supported by a nut 17 carrying a second set of resilient bristles 18 of similar construction to the first set of bristles 12. The nut 17 is mounted to a guide 19 which is in turn connected to a housing 20 carrying the end of reverse traverse screw 14 remote from the drive means 4. Rotation of the shaft 9 causes rotation of reverse traverse screw 14 which, through engagement of the thread follower 16 in cam grooves 15, causes axial movement of the nut 17 along guides 19 relative to the body member 11. The housing 20

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contains a bearing, and is provided with a set of wheels 21 for engaging the internal surface of the pipeline 2.

Referring in detail to Figure 2, the turbine housing 6 comprises a cowling 22 supporting the stator 7 on struts 23, the cowling 22 being sized to have a small clearance from the internal wall of the conduit 2. The rotor 8 is arranged behind the stator 7 and the surfaces of the rotor and stator are oriented such that the stator 7 causes the direction of fluid flowing therethrough to change so that the fluid contacts the blades of the rotor 8 in a direction generally perpendicular to the faces of the blades to ensure maximum efficiency of energy transfer.

Referring to Figure 3, the reverse traverse screw 14 having cam grooves 15 is received within housing 20 supporting wheels 21 which in turn engage the internal surface of the conduit 2. The wheels 21 and rear bristles 18 are alternately spaced circumferentially around the axis of the vehicle.

Figure 4 shows a cross-sectional view along the line C-C in Figure 1. The nut 17 carries thread follower 16 which engages one of the grooves 15 on the reverse traverse screw 14, and the nut 17 is adapted to slide along guides 19 located within the housing 20. The bristles 18 project through elongate slots 24 in the housing 20.

The operation of the vehicle 1 described with reference to Figures 1 to 4 will now be described.

As fluid flows in the direction of arrow D shown in Figure 1, movement of the fluid through the stator 7 causes the turbine rotor 8 to rotate, which in turn causes rotation of the shaft 9. This in turn causes rotation of the reverse traverse screw 14, as a result of which the thread follower 16 engages a first one of the cam grooves 15 and causes the nut 17 to slide longitudinally relative to the body member 11. This causes

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the first bristles 12 and second bristles 18 to be moved away from each other.

Because the bristles 12, 18 are oriented backwards relative to the direction of travel of the vehicle, the frictional force of the bristles 12, 18 against the wall of the pipe 2 is greater in the rearward direction than in the forward direction. Accordingly, the rear bristles 18 do not move or move very little relative to the wall of the conduit 2, whereas the forward bristles 12 and body member 11 are urged forwards.

As the nut 17 reaches the end of its travel along the cam groove 15 of the reverse traverse screw 14, the thread follower 16 is so shaped that it is forced to engage the other cam groove 15 and is caused to move in the opposition direction relative to the reverse traverse screw 14. As a result, the rear bristles 18 and front bristles 12 are moved towards each other. The forward bristles 12 have greater resistance to moving backwards than the rear bristles 18 have to moving forwards, so the forward bristles 12 and body member 11 remain stationary, or only move very little, relative to the pipe wall 2 and the rear bristles 18 are moved forwards until the nut 17 reaches the forward end of its travel along the reverse traverse screw 14. The process then repeats itself, and the vehicle 1 travels along the pipe 2.

It will be appreciated by persons skilled in the art that the above embodiment has been described by way of example only and not in any limitative sense, and that various alterations and modifications are possible without departure from the scope of the invention as defined by the appended claims. For example, more than two sets of bristles 12, 18 may be used, or the bristled may be replaced by elongate elastomeric members. Alternatively, the bristles 12, 18 may be replaced by electrically or magnetically operated gripping means which are urged radially outwards from the vehicle body to apply a gripping force to the internal wall of the conduit.

CLAIMS

1. A vehicle for travelling along a conduit having fluid flowing therein, the vehicle comprising:
 - (a) propulsion means including first surface engaging means for engaging a surface of the conduit to apply a gripping force thereto, and at least one second surface engaging means located forwardly in use of said first surface engaging means and adapted to engage a surface of the conduit to apply a gripping force thereto and adapted to move towards and away from said first surface engaging means, wherein the or each said second surface engaging means in use applies a greater gripping force when it is moving towards said first surface engaging means than when it is moving away from said first surface engaging means, and said first surface engaging means applies a larger gripping force when it is moving away from the or each said second surface engaging means than when it is moving towards the or each said second surface engaging means, to cause said propulsion means to move along the conduit;
 - (b) drive means having a shaft portion adapted to be rotated as a result of fluid flow relative to the drive means; and
 - (c) connector means for causing the or each said second surface engaging means to move away from said first surface engaging means as a result of rotation of said shaft portion.
2. A vehicle according to claim 1, wherein said first and/or second surface engaging means comprises a respective plurality of resilient bristles.
3. A vehicle according to claim 1, wherein the first and/or second surface engaging means comprises a respective

electrically and/or magnetically operated gripping means.

4. A vehicle according to any one of the preceding claims, wherein said first and/or second surface engaging means is mounted to a respective vehicle body portion and adjacent pairs of said body portions are adapted to move relative to each other.
5. A vehicle according to any one of claims 1 to 3, wherein said first and/or second surface engaging means is mounted to a single vehicle body portion.
6. A vehicle according to any one of the preceding claims, wherein said drive means comprises at least one turbine.
7. A vehicle according to claim 6, wherein at least one said turbine is a multi stage turbine.
8. A vehicle according to claim 6 or 7, wherein the drive means further comprises at least one stator for altering direction of fluid flow to increase efficiency of transfer of energy from the fluid to at least one said turbine.
9. A vehicle according to any one of the preceding claims, wherein said connector means comprises a first part having at least one first cam groove and a second part having at least one cam projection adapted to engage at least one said first cam groove such that rotation of said shaft portion in a first sense causes at least one said cam projection to move along a said first cam groove to cause at least one said second surface engaging means to move away from said first surface engaging means.
10. A vehicle according to claim 9, wherein the first part further includes at least one second cam groove to cause at least one said second surface engaging means to move towards said first surface engaging means.

11. A vehicle according to claim 10, wherein the or each said first cam groove has a smaller pitch than the or each said second cam groove.

12. A vehicle according to claim 10 or 11, wherein at least one said first cam groove is connected to at least one said second cam groove, and at least one said cam projection is adapted to transfer between said first and second cam grooves to reverse the direction of travel of the first part relative to the second part.

13. A vehicle according to any one of the preceding claims, further comprising biasing means for urging at least one said second surface engaging means towards said first surface engaging means.

14. A vehicle according to any one of the preceding claims, further comprising at least one gearbox connected between said drive means and said connector means.

15. A vehicle according to any one of the preceding claims, wherein the vehicle is articulated.

16. A vehicle according to claim 15, wherein the vehicle is articulated rearwardly of said drive means in use.

17. A vehicle according to any one of the preceding claims, further comprising braking means for increasing the fluid drag of the vehicle.

18. A vehicle according to claim 17, wherein the braking means comprises at least one sealing means for sealingly engaging the internal surface of the conduit.

19. A vehicle according to any one of the preceding claims, further comprising one or more wheels for engaging the surface of the conduit.

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20. A vehicle according to any one of the preceding claims, further comprising conduit inspection means.

21. A vehicle according to any one of the preceding claims, further comprising conduit repair means.

22. A vehicle for travelling along a conduit having fluid flowing therein, the vehicle substantially as hereinbefore described with reference to the accompanying drawings.

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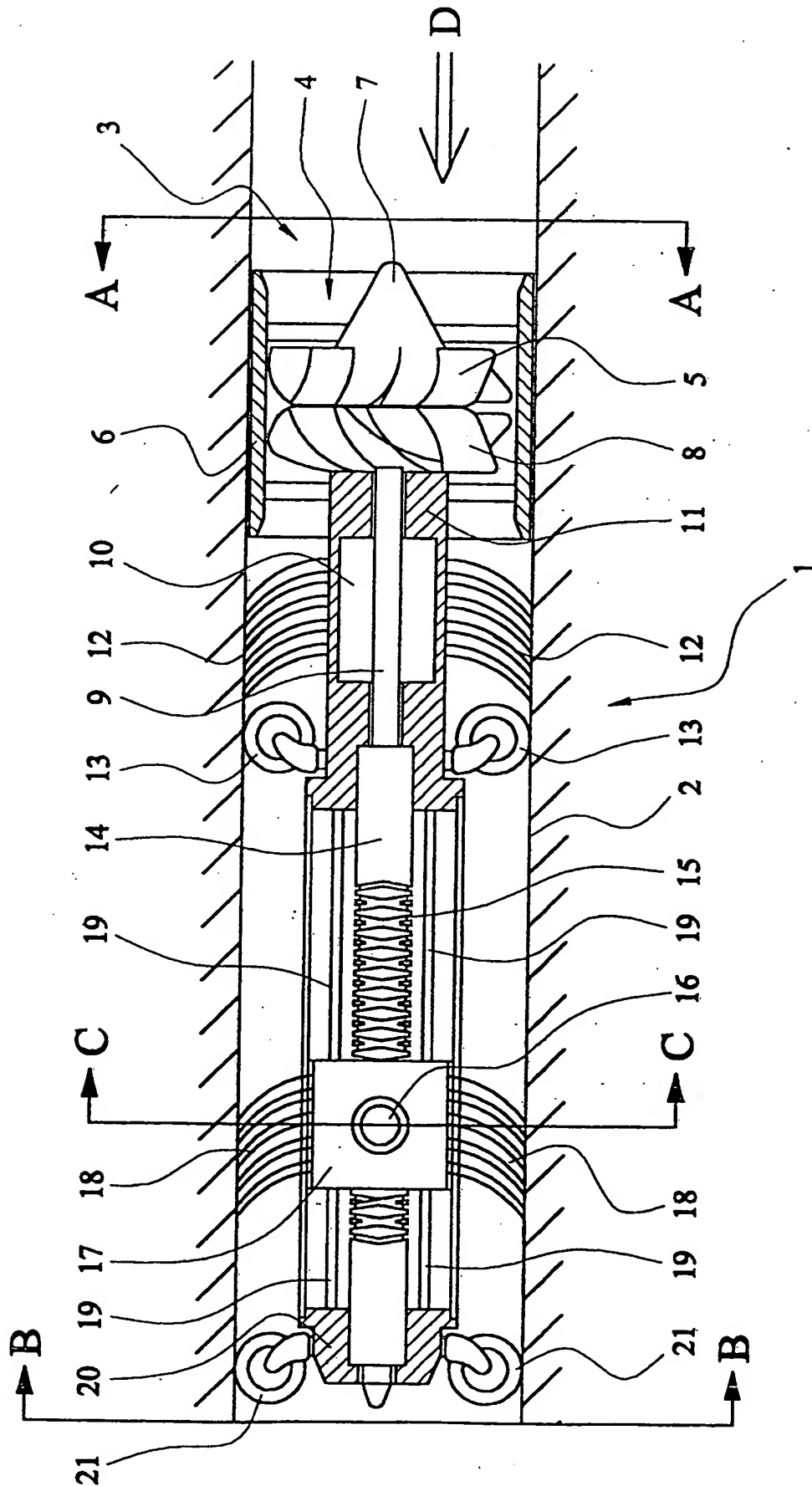


FIG. 1

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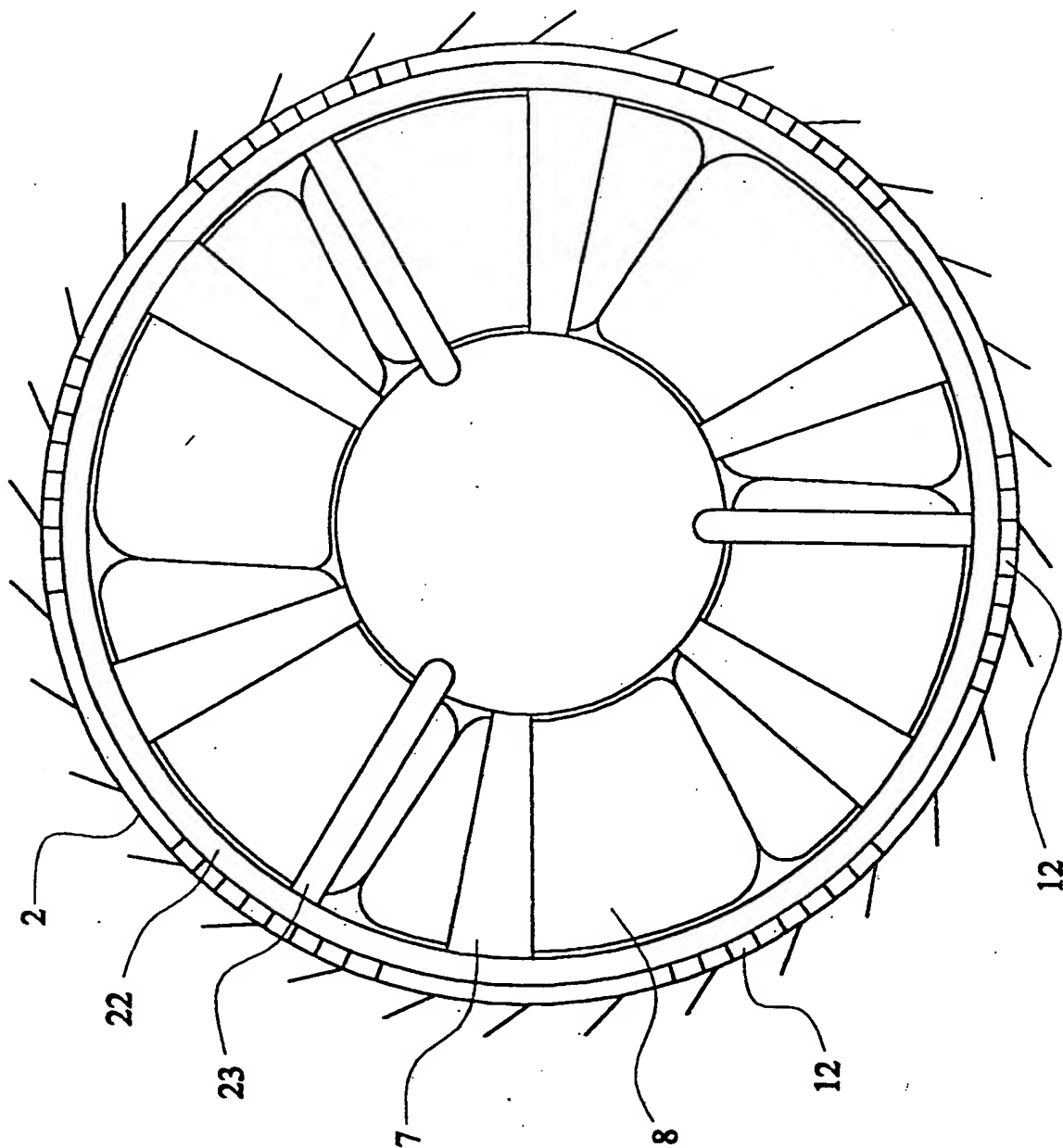
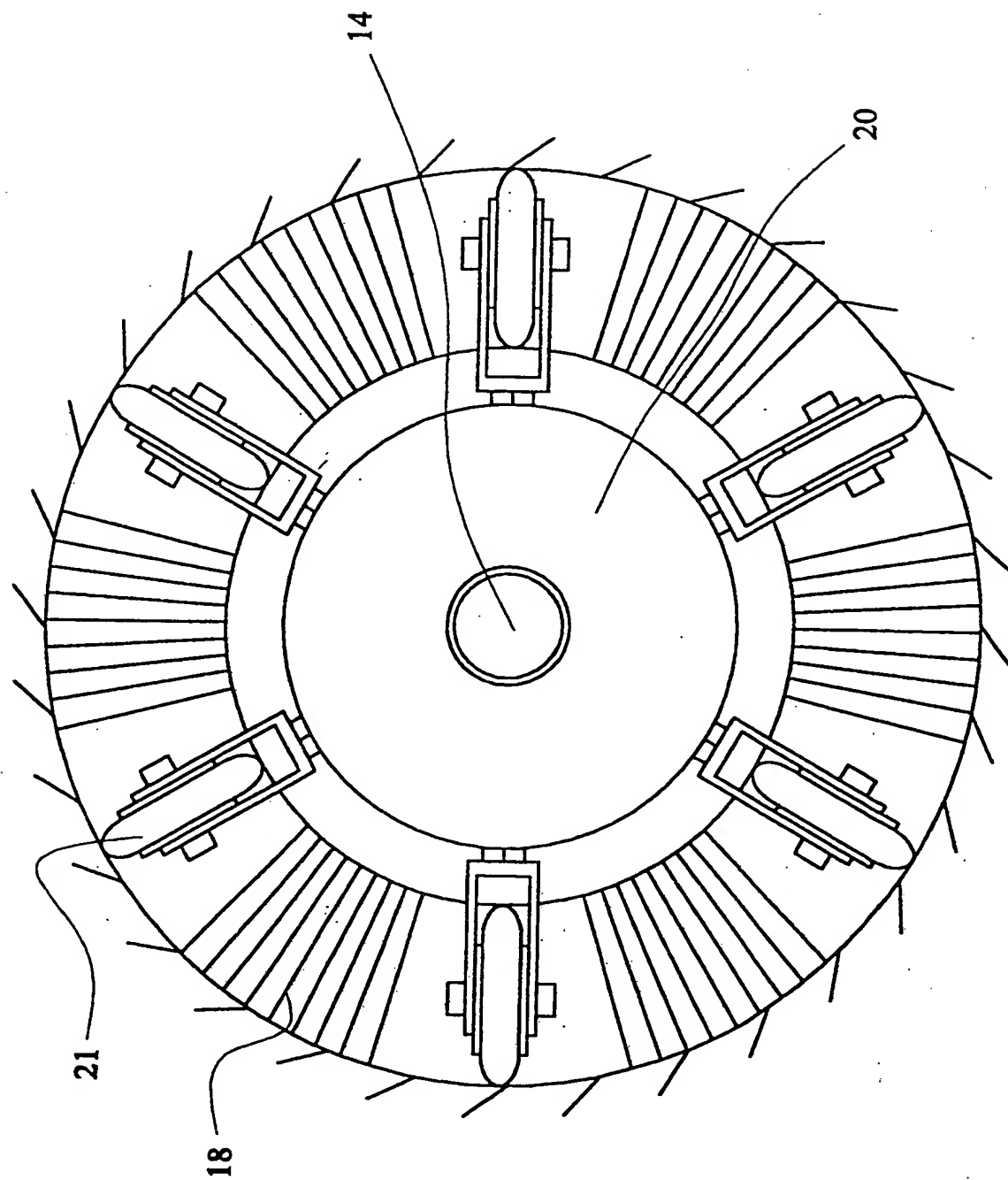


FIG. 2

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FIG. 3

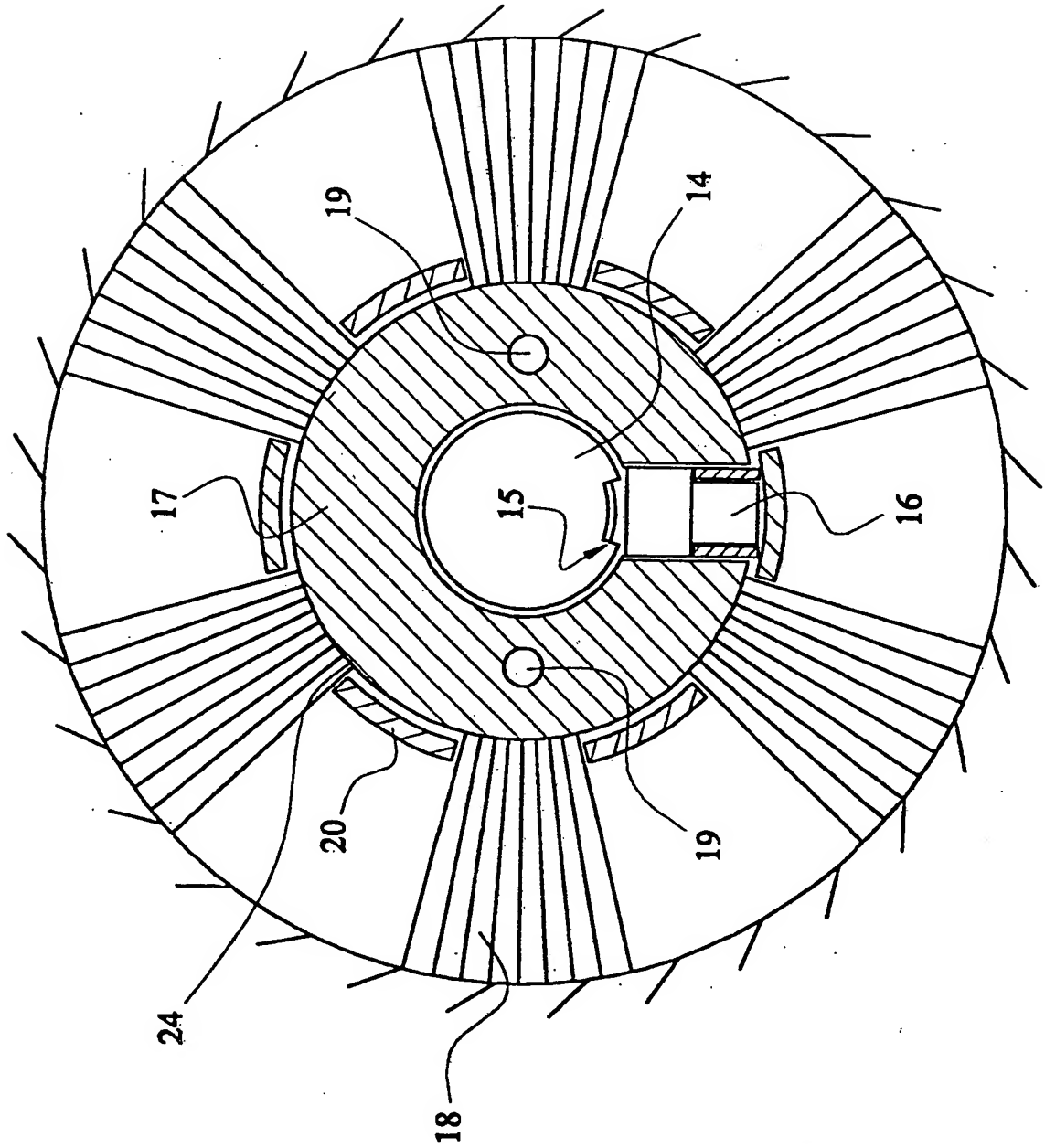


FIG. 4